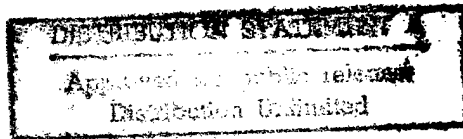


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# West Europe Report

SCIENCE AND TECHNOLOGY

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## ADVANCED MATERIALS

### DUTCH INNOVATION PROGRAM FOCUSES ON FIBER-REINFORCED MATERIALS

Rijswijk PT AKTUEEL in Dutch 27 Mar 85 p 5

[Article by Joost van Kasteren: "IOP Offers Guide to Polymer Research: Innovation-Oriented Research Programs, Part One"]

[Excerpts] "It is perhaps somewhat troublesome to contract research projects out to one or more institutes. But that is not the purpose of an Innovation-Oriented Research Program (IOP). Then the conversion effect is gone." The chairman of the IOP for polymer composites and special polymers [PCBP], Mr R. J. Schliekelmann, sees indicating the direction for research at universities and post-secondary institutes as one of the important purposes of the soon to be established research program.

#### Gradient for Development

Against this background, the decision was made to begin an innovative research program (IOP) for polymer composites and special polymers. The chairman of the program commission: "It is clear that several areas, such as the development of new materials and the development of background knowledge for new applications of polymers, are the subject of intensive research abroad. If one wishes to evaluate Dutch research, then one should look not only at the 'state of the art' abroad, but also at research efforts there. An assessment of the dynamics; where were they yesterday, where will they be tomorrow. I call that the gradient of development, and for a number of areas it is very steep."

If the Netherlands counters that with only modest research activity, then the lag only becomes larger, according to Schliekelmann. This is the reason for his advocacy of energetic research activity in a limited number of selected areas.

Since what is involved is a so-called innovative research program (an idea from the Innovation Memorandum intended to bring researchers and industry together for focused research), it is especially a question of topics in the "precompetitive" domain. It is true that they are application-oriented, but at the same time accessible for general use by industry. "One could say up

to a certain point that in recent years many research topics in the area of special polymers and composites have been determined by current fashion. Through the IOP, we want to bring up specific topics in order to thus provide direction for research."

#### Fiber-Reinforced Materials

In the basic program endorsed this past January by the steering committee for IOPs, a choice was made from among an immense series of research topics. Emphasis was put on research in fiber-reinforced materials, and specifically background research enabling applications of this material beyond the realm of aircraft construction and sports equipment.

Schliekelmann mentions as a possible research topic an exhaustive description of the qualities of the synthetic material (matrix polymers) as well as of the fibers and of a combination of the two. This should include not only the breaking strength of the materials and the differences between them that can lead to problems, but also more theoretical research on what happens in the interface between fiber and polymer. In addition, the program commission of the IOP/PCBP (as it is abbreviated in jargon) feels that money and research capacity should be put into processing technology. Not only for composite materials, but also for non-reinforced synthetic materials and rubber.

In previous studies, including a preliminary study by the Central Institute for Industrial Development, other areas of research were also mentioned. For example, research into polymers with special characteristics, such as electrical conductivity, and research into so-called self-reinforced polymers. This is synthetic material in which the chains assume a particular direction during setting. By manipulating this, the breaking strength in a particular direction can be increased.

These special polymers are not receiving any priority in the proposed basic program because, according to Schliekelmann, research in this area requires more time and effort than the 4 or 5 years available for innovation-oriented research provide.

Another problem that clearly lies outside the realm of the IOP, but which the program commission does in fact want to stress, is the lack of test facilities. Industry, and in particular small companies, does not have the opportunity to test new material and processes. This gap has come about because the Synthetic Material and Rubber Institute of the TNO [Dutch Central Organization for Applied Scientific Research] has in this respect not been what it should have been. The program commission is arguing in favor of a study into the possibilities of filling this gap.

A comparably sensitive spot is in education in the area of polymers. Although this is, strictly speaking, of no concern to the program commission, it does feel that this area is so essential that a large number of pages are devoted to it. Schliekelmann: "If we want innovations to take root, then it is absolutely necessary that the level of expertise be boosted."

For that matter, he generalizes this to include expertise in the area of materials as a whole. "The knowledge of materials in the Netherlands, certainly among designers, is, quite frankly, poor. You see applications that make your hair stand on end. As a consequence, I would argue in favor of the establishment of a Central Council for Materials in the Netherlands. Something comparable to, say, the General Energy Council; at any rate an advisory board for the government in the area of materials."

The last main topic in the program commission's list of priorities is the reuse of new materials. According to Schliekelmann, waste is becoming a gigantic problem. "No one has concentrated on this yet, but what are you to do with composite materials after they have served their purpose? Perhaps bury them."

#### Lacking in Capacity

An amount of a little under 12 million guilders has been budgeted for the IOP for the period from 1985 to 1989. In essence one can count on double that amount since one of the stipulations for subsidies from the IOP pool is that the research institution itself provide 50 percent of the necessary amount. "I don't think money is the biggest problem," Schliekelmann says. "The limiting factor is research capacity in the Netherlands."

The program commission maintains in the report that 154 human years are presumably available in the 4 years of the IOP. That is not particularly much in view of the extent of the field of research and of the depth necessary for the research. "The limited capacity in particular forces us to limit research topics," Schliekelmann says. "Before pursuing other possibly interesting subjects of research, we must first guard against a lag with respect to [research in] other countries."

#### Fiber-Reinforced Synthetic Material

It is obvious that the program commission is assigning the highest priority to fiber-reinforced synthetic material. In this area, the Netherlands has built up a leading position, in part through Fokker (Schliekelmann's former employer). As early as during the development of the Friendship, circa 1950, a choice was made for glass fiber-reinforced polyester. Fokker led the way in this, as well as in the area of glued joints.

The Netherlands also plays a leading role in the new generation of fiber-reinforced synthetic material, whereby not glass fiber, but carbon fiber is enclosed in a synthetic material matrix. It is again the aircraft industry that has taken the lead in this. Carbon fibers are embedded in so-called "thermosetters," non-deformable synthetic material. In addition to aircraft components, a number of articles of sports equipment have in the meantime been made of this material.

The main topic of the IOP, fiber-reinforced synthetic material, is oriented in particular towards applications in other branches of industry. A subdivision was made into three subtopics: adhesion between fiber and resin, the connection between the properties of fiber and resin, and finally, methods for non-destructive testing of the material.

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ADVANCED MATERIALS

LIMOGES IN FRANCE TO FOCUS ON CERAMICS RESEARCH

Paris AFP SCIENCES in French 28 Mar 85 p 92

[Unsigned article]

[Text] Limoges--Limoges, the traditional capital of porcelain and enamels, is determined to make its bid for the future technology associated with the development of industrial ceramics, and is multiplying its appeals to investors to create the French "ceramics hub."

As pointed out by Limoges economic and university groups, this is not a break, but on the contrary, a continuity between the traditional "firing arts" and the prospects of using so-called engineering ceramics in electronic and thermomechanical applications (shuttles and special bases, thermal engines, and so on).

Philippe Boch, director of the National Higher Education School for Industrial Ceramics (ENSCI) in Limoges, thus states that "if the technology has to progress significantly, it could not do so without the ancestral know-how which provides an additional advantage to attract industries that would want to locate in Limoges."

Ceramics in the Limousin involves 260 enterprises: suppliers of raw materials or equipment, and manufacturers of ceramics items, employing about 5000 people for revenues of 1.2 billion francs, 33 percent of it in exportation.

The development of modern industrial ceramics has essentially bypassed Limoges, and today its decision makers do not want to fall back into yesterday's apathy. They have decided to attract a new generation of investors by offering local know-how, kiln engineering, custom machinery, chemical products, dyes, and especially, quality university education and research.

The University of Limoges thus offers mastery in ceramics sciences and technology, a diploma for advanced studies in ceramics materials, and a doctor's degree. Moreover, ENSCI offers the only French ceramics engineer diploma; about 60 high level specialists are graduated every year.

In research, the university and ENSCI collaborate at the CNRS (National Center for Scientific Research) New Ceramics Laboratory, which has more than 50 permanent employees. The research essentially covers ceramic processes, electronic ceramics, and thermomechanical ceramics. Other university laboratories in Limoges complement this research; they are the laboratory associated with CNRS, which works on optical communication and microwaves, and the laboratory of the Communication Research Institute (IRCOM), which focuses its activities on high frequency dielectrics and optical fibers.

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AEROSPACE

SEP ENTERS FRANCE'S SECONDARY STOCK MARKET

Paris AFP SCIENCES in French 28 Mar 85 p 36

[Unsigned article]

[Text] Paris--Ariane's engine builder, the European Propulsion Company (SEP), which will enter Paris' second stock market on 29 May, is forecasting an annual growth of 15 percent over five years thanks to the industrialization of the European rocket, indicated the company's president, Roger Legards on 27 March.

About 13 percent of the capital, amounting to 38,000 shares, will be offered to the public. In parallel, SEP has decided to take an "action to benefit its personnel," by distributing share purchase options representing 3.2 percent of the current capital. The personnel's share price should be 700 francs.

SEP, which in 1984 became a subsidiary of SNECMA (National Company for Aircraft Engine Studies and Construction), had recorded a drop of 5.3 MF in 1983 (compared to 16.8 MF in 1982) due to the failure of Ariane's fifth launch. But today, points out Mr Legards, Ariane is in an "industrialization phase" with a goal of about six launchings per year.

In 1984, SEP announced a net result of 15.5 MF for revenues of 1.8 billion francs, 40 percent of them achieved from Ariane engines. Its present orders amount to about 3 billion francs. It expects to double its revenues by 1990.

Activity in the area of ballistic missile propulsion (40 percent of 1984's revenues) should be "stable." On the other hand, the company expects a strong development in new products (20 percent of revenues): image processing, small rocket propulsion, composite materials, and so on.

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## COMPUTERS

### BREAKDOWN OF PROJECTS, COUNTRIES, FUNDING FOR ESPRIT

Rijswijk PT AKTUEEL in Dutch 6 Mar 85 p 7

[Article by Casper Schuurin: "European Commission Is Optimistic About Esprit: Interest of Industry for Esprit-II Is Great"]

[Excerpts] The European Commission is very optimistic about Esprit, the European answer to American and Japanese efforts in the area of new information technology. As early as the end of 1985, a close look will be taken at whether an Esprit-II program is desirable. This could be--in terms of money--just as extensive as Esprit-I (1984-1988); a governmental contribution of 3.75 billion guilders. Industry contributes half of the amount. Some 2,000 of the 10,000 researchers in Europe active in this area of research have been involved with Esprit. "It's going quite well. The reaction by industry is encouraging. It is the first time that companies are learning from one another. The first patent has already emerged from Esprit," says the new EEC commissioner for industry and research, Dr Karl Heinz Narjes.

The first round of the main program of Esprit-I, which was launched in March 1984, has produced 106 projects, which are bringing together 344 companies, 107 universities and 97 institutes. Narjes thinks that there will be 2,000 of these in 1986. Universities participate in 75 percent of the projects, large companies (with more than 500 employees) in 70 percent and medium-sized and small companies in 50 percent. Only two percent of the contracts have been awarded to non-European multinationals: IBM, ITT AT&T and Digital. Narjes does not entirely share the critical view that smaller companies are scarcely of use to Esprit. "A large part of the work does indeed go to these companies."

The deadline for the second round in order to be able to participate in a new series of projects is 25 March. An open house for this was organized in Brussels at the beginning of February. "Interest was overwhelming. We were expecting 250 people, and 850 were there, all having paid for their own travel and lodging. After 1 April, panels of independent technical experts will take a look at the proposals submitted. After a first long list, there will be a shortened list at the end of July, after which the recommendations of the

Esprit Advisory Board, another body of independent people, will also be included. The governments are allowed to examine these lists because the research should not go against national policy," says Richard Nobbs of the Esprit Task Force.

#### Small Countries Come Into Their Own

Approximately 10 experts are taking part in each of the 106 projects in the first round. Since on the average five companies are involved in one project, that amounts to two people per company, which is not very much at all, Hobbs says. He thinks that these 1,200 directly involved individuals will have grown to 2,000 by the end of 1985. In awarding the projects, a certain amount of consideration is being given to dispersal among the countries. The large EEC countries are each represented by 21 to 23 percent. The small countries come reasonably well into their own, especially Belgium, which has set up good organization. "The Netherlands is certainly doing less than Belgium. How information is disseminated is very important. There are scarcely any small companies from the Netherlands involved in Esprit. The Dutch universities could also do more, even though those in Amsterdam (including in particular the CWI, the Center for Mathematics and Information Theory), Nijmegen, Utrecht and the Twente Institute of Technology appear on the list of contracting parties."

Philips appears often on the list, next to TNO [Dutch Central Organization for Applied Scientific Research], OCE van der Grinten and the software houses BSO and Courseware Europe B.V. Philips is participating in 17 projects, as main contractor in three of these. Eleven of the projects are considered important. A sum of 25 million is involved in them. Philips is cooperating with a total of 50 partners in Esprit. Unofficial sources say that it is Philips and Siemens in particular that attract research, because they are involved in 75 percent of the research. However, the contributions of English companies such as General Electric and Plessey are not inconsiderable.

#### Investment in Research

These same unofficial sources say that trade and industry are continuing to look heavily towards short-term prospects, which is perhaps not that illogical for them. For these companies, however, it is then rather difficult to become involved in a long-term research program. A lack of interest in medium- and long-term prospects is fatal, now that it is clear that Europe--as it is emphasized--is still losing out in market share to the United States and Japan. Too little is being invested in research and development. And yet one can remain in business only by investing in research and not by only wanting to make money. More cooperation will be necessary in this fragmented European market, according to these authorities on the Brussels circuit.

Each year of the four-year Esprit-I program, there will be calls issued for a round of research projects. Not only will more and more people be involved in it, but more money will be put into it as well. A sum of 205 million ECU (1 ECU corresponds to approximately 2.50 guilders) was earmarked for the 1984

round, while 200 million is going to the 1985 round. In this way, 405 million of the 750 million being contributed by the European Community for 5 years would already be spent.

Although a large number of the projects extend for longer than one year, approximately 75 percent of the money will have already been locked up by the end of 1985. This is the reason for the idea of considering the establishment of a second Esprit as early as the end of 1985 and of rounding out discussion on it next year.

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## COMPUTERS

DUTCH EXPERT: EUROPE TO HAVE OPTICAL PROCESSOR WITHIN A YEAR

Rijswijk PT AKTUEEL in Dutch 13 Mar 85 p 3

[Article by Casper Schuurin: "Optimism Among European Researchers on Future of Optical Computer"]

[Excerpts] A new effort is under way in Europe to cope on a long-term basis with competition from Japan and the United States in the area of computers. Scientists from 18 universities and research institutes in six countries are working together on the so-called optical circuit, also known as the light chip. This could lead to an optical computer, which works not with electronic circuits, but rather with light circuits. However, there is extreme scepticism about the optical computer at the Philips Physics Laboratory, which is not participating [in the project].

Professor Dr Paul Mandel of the Department of Mathematics and Physics at the Free University of Brussels is firmly convinced that in a number of months, and certainly within a year, the experimental possibility of a primitive optical processor will be realized. He admits that a lot has to take place before an optical computer can then come about, and as a consequence he cannot provide any answers as to when things will be that far along. According to Mandel, 80 percent of the researchers in Europe working in this area have now been brought together in a cooperative venture to which the European Commission is granting financial support. Nothing is going on in this domain in the Soviet Union or in Japan, according to Mandel. To his own surprise, there is no perceptible activity whatsoever in the Netherlands either, although he does suspect that something is going on in the Philips Physics Laboratory.

Dr H. Bosma, deputy director of the laboratory and the man responsible for computer systems, says that he knows little about the subject. "It is indeed under discussion here. It is possible in principle, we are naturally working on optical communications, we make optical components, that much is indisputable. Up to a certain point, we are integrating them as well. Other than this, it depends on what you actually mean by an optical computer. Of course it is possible to send a beam of light through a lens and thus solve problems, without that being directly computer-like. As far as a true optical computer is concerned, in which you connect optical signals with optical signals, a

whole lot of them close to one another, we think that in terms of space and time it is still far from being worthwhile. Industrially, an optical computer is still nowhere."

Yet Bosma is careful not to entirely rule out an optical computer for specific problems in the distant future.

#### Europe Is Proceeding

It is striking that something is clearly going on in this area elsewhere in Europe, even if it is exclusively at universities and research institutes. Research is under way in particular at the Heriot-Watt University in Edinburgh, where according to Mandel the first optical circuits will be made as well. Also participating in the EEC program are the above-mentioned Free University of Brussels, the French national research center CNRS [National Center for Research] in Strasbourg, the Universities of Milan, Pisa, Florence and Frankfurt, the Fraunhofer Institute for Instrumental Physics in Freiburg, the Max Planck Institute for Quantum Optics in Munich and the Berlin Institute of Technology. In addition, contracts have been signed with the University College in Dublin and the Royal Signals and Radar Establishment in Malvern, England. Mandel is now talking about 60 to 80 people in 19 groups at 18 institutions, with two supposedly on the waiting list to participate.

This European initiative, known officially as "European Joint Optical Bistability" (EJOB), is furthermore involved in strong competition with a group in Tucson, Arizona. The budget of the one group there corresponds closely to that of the EJOB (1.8 million ECU compared to 2.5 million for 2 years). The (smaller) American group is "aggressively conducting experiments, but they are weak in theory; we are equally strong in both. The competition between us is progressing with varying success," Mandel says. In addition, "optical bistability," which is what is primarily at stake, was foreseen by IBM as early as 1964. It happened again in 1969 at MIT, and in 1976 it was recognized by Bell Laboratories. The first results with semiconductors were announced in 1979. The question now is to develop an optical transistor and optical stability on a chip, Mandel maintains.

"We find ourselves in a good position to dream of an optical computer. Optical transistors work, there are also optical binary systems, and we are hoping for an optical clock, which will also be necessary, but the scope of which is still in fact a problem. Don't forget that this research is only 3 years old. At Bell Labs they had such a clock as early as 1976, although it weighed several tons," Mandel says. He shows how in an electronic circuit, speeds of one nanosecond (ns, or  $10^{-9}$  second) are used. "In optical systems, one works with one hundredth of a  $10^{-15}$  second (femtosecond, or fs). A considerable amount of energy is necessary for this. A Cray supercomputer works with 10 100 million circuits per second; we ought to be able to do it with a factor that is 10 to 1,000 times faster, that would be good. The big advantage of optical systems is after all the much greater speed. Several milliwatts of energy are necessary for 20 100 nanoseconds; 5 years ago no one thought of less than one kilowatt. Thus, it is fast. For one hundredth of a femtosecond, energy amounting



to many kilowatts up to one megawatt is still necessary. There are no remaining physical barriers to overcome, but we will first have to prove it."

#### Critical Point of Semiconductor Material

Theoretical and experimental physicists are now working together in EJOB on tackling problems. The necessary materials form the most important aspect of this. Semiconductors are indeed now in use, but no one yet knows what material is ideal for optical properties. It is possibly zinc selenium, of which interferential filters are currently being made. "If everything has been developed to perfection, then the questions arises of how the architecture of a computer should look. How do you make use of everything without copying an electronic computer? Optical processors can go in a parallel direction, just like in the computers of the fifth generation, the development of which is being pursued in Japan as well as within Esprit. Thus, we don't really know how an optical computer should be constructed. However, electronic computers will not become outmoded once the optical computer arrives. There will be specific applications for both. For the optical [computer] they are in the area of pattern and image recognition in particular. Nor does the optical computer need to become a competitor of the fifth generation computer," Mandel says.

#### Stimulation of Cooperation Proceeds

The European Community is definitively proceeding with the plan to strongly promote cooperation between researchers in Europe. The European Commission is now addressing itself to interested parties by way of the professional press in order that they participate in the plan to stimulate cooperation. Since an experimental campaign has run successfully for the past 2 years, it was decided to make a sum available for 1985 and 1986 that is five times as large (35 million ECU, or even 88 million).

It is intended that the mobility of researchers--from both universities and industry--be sharply increased through all sorts of means. In this program, they must be actively brought into contact with one another. Specifically, cooperation between researchers from various countries in multidisciplinary projects is being promoted. Moreover, it is deemed desirable to give young researchers the opportunity to specialize in promising areas of research and in so doing to help them develop professional careers, in particular where acquiring a job in industry is concerned.

The stimulation program must become an effective mechanism for leveling all sorts of barriers that still exist--specifically, language, differences between university and industry and differences between disciplines. The program is open to all branches of the sciences. The organization in Brussels expects to receive three to four times as many applications as it did during the experimental period, when 76 projects were set up. Three forms of support are foreseen for the project. One involves furnishing the means for researchers of various nationalities to implement research together in laboratories. More than two laboratories from more than one country must be involved in this. A

second possibility is to bring together specialists in various disciplines and from more than one EEC country in a multidisciplinary project. The granting of subsidies is a third way in which to make short visits by researchers possible within the Community or to pay the salary of a researcher who is participating in a team, or some such arrangement.

"Science in Europe is split up, both geographically and in terms of discipline and organization," Charles White of the Policy Directorate of the Directorate General for Science and Development of the European Commission said on 31 October 1984 in PT AKTUEEL. The readiness of research efforts to compete is presently limited by the fact that communication between scientific institutions is rendered insufficient in all directions by too little mobility, as well as the fact that there is little variety in forms of cooperation and a shortage of placement possibilities for young research graduates. Initiatives on a national level are extremely limited and "that leads to a sometimes irreparable waste of intellect," according to the European Commission in a policy paper.

On 26 February in Brussels, White announced to science journalists from all over Europe how the plans are now to be further worked out. He also let it be known that a project is in fact already under way. This involves work on an optical computer (see accompanying article). Professor Dr Paul Mandel of the Free University of Brussels, who is in charge of this research, believes that such a project is only possible thanks to the EEC stimulation plan for cooperation. "If we did not have this opportunity for greater mobility, nothing would have come of this cooperation. Then we would return to our own little rooms, since the universities enable us to make only one trip a year."

Interested parties can address themselves to: General Directorate for Science, Research and Development, Directorate A, Division XII-A-2-Stimulation Action, European Commission, 200 Rue de la Loi, B-1049 Brussels.

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COMPUTERS

BRIEFS

AGENCY IN TWO VENTURE FIRMS--Televerket [the Swedish Telecommunications Agency] has bought into the two venture capital firms Infovox AB and SU Infologics AB. This was done through directed issues of Televerket's holding company Teleinvest. Televerket presently holds about 40 and 45 percent, respectively, of these venture capital firms. Svenska Utvecklings AB (SU) owns shares [in both] equal to that of Televerket. Infovox is the first firm in the country to have realized commercial results from research in the area of "talking" computers. Infologics has done the same in the area of artificial intelligence, the so-called expert system. With the aid of Infovox's speech analysis equipment Televerket hopes to be able to control certain functions in the telecommunications network directly with the human voice. [Text] [Stockholm SVENSKA DAGBLADET in Swedish 20 Jun 85 p 27]

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## FACTORY AUTOMATION

### FRG BUILDS 'FACTORY OF FUTURE' TO COMPETE WITH U.S., JAPAN

Duesseldorf VDI NACHRICHTEN in German 15 Mar 85 p 20

[Article by E. Schmidt: "Research for the Factory. Flexible Manufacturing Automation Tries to Gain a Lead over Japan and the United States"]

[Excerpts] Many Germans proud of their country's export may still think that the world's workshop is located here, but even if this is not the case there is at least the competition with Japan and the United States. A lot of money is spent in order to meet this constant challenge. However, a look into laboratories for research in production technology shows that it is put to good use. What is developed here will become the standard in the streamlined factory of the future.

A new research center for production automation and robot technology combines a flexible manufacturing system and a flexible assembly system in a 1200 square meter large hall in Dornach close to Munich. It is part of the Institute for Machine tools and Business Administration Studies (iwb) of the Technical University of Munich [TU] and was dedicated in February in the presence of Anton Jaumann, Minister of Economics for Bavaria.

As professor and doctor of engineering Joachim Milberg, who holds the chair for machine Tools and business administration, explained, those who actually work in companies increasingly demand manufacturing facilities which can be retooled easily and thus can be used for shorter production runs as well. He stated that a number of highly flexible individual elements are indeed already available for this purpose, however, there are still "very few integrated systems in the world which are functionally interconnected." It is exactly these systems which are being researched and tested in Dornach, which is Milberg's new research center.

The new research center, which was established in part in response to the wishes of the local industry, represents an investment of approximately DM7.5 million, one-third of which was provided by the government, while the other two-thirds were provided by industry in the form of "loans" etc. Operating expenses for the activities in Dornach are to be financed primarily through "funds from third parties" as well. Milberg's Technical University institute as a whole is financed by the operating budget of the TU, by research projects

for public and semi-public support facilities and by direct contracts from industry, each covering one third of the expenses.--Incidentally, this is a point which repeatedly has given rise to criticism: some students feel, for instance, that research supported by funds from third parties represents something like a "sell-out of universities to the interests of private industry."

The modern image presented by the Dornach facility is evidenced by Milberg's statement "I do not know anybody else who is taking on something as complex as our project for the automatic assembly of (BMW) car doors." And in fact most visitors were very impressed when they saw, for instance, how robots assembled door locks--an activity which requires numerous individual "manual steps"--and even weather stripping for windows. For the door assembly alone 12 interconnected robots were used which are all monitored by a central computer. In addition, there is the manufacturing system which consists of a saw cutting center, two milling machines and a machining center; an automatic floor vehicle, on which a handling device is mounted, moves back and forth and continuously supplies the machine with new workpieces following a carefully designed plan.

As Milberg emphasizes, it will still be 4 to 5 years before "what we are doing here now can be put into practice in industry in general." When asked whether this research was possibly carried out in the interest of large industry only and would thus put medium-sized firms at a disadvantage, the machine tool expert stressed that a lot of know-how, naturally also in the form of newly trained engineers, would be passed on to smaller and medium-sized firms. Furthermore, "we gladly advise companies who come to us.

Such consultation seems to be very necessary since Milberg himself feels that while Germany need not be afraid of a comparison with the United States and Japan with regard to the "technical possibilities," when it comes to practical applications, however, "Japan may be somewhat ahead." Yet: "During the last 12 to 18 months there have been many new initiatives here in Germany, too, to move things ahead."

Professor Dr. Wolfgang Wild, president of the TU Munich, also emphasized the importance of "high technology" for the economy of a country, since today this area is expanding "much more rapidly than traditional industries." Thus, Wild limited high technology to those industries whose expenditure for research and development--expressed as a percentage--is at least twice as high as the industry average. He also stated that in Germany only 4.7 percent of the production value qualifies, while the figure for the United States is 10.8 percent. And in Germany only one out of eighteen of those employed in industry is working in this high-technology area, while it is one out of eight in the United States.

According to Wild, in comparison with Japan and the United States the situation is such that the United States has a "well recognized lead in biotechnology office communications, computer technology, CAD/CAM, satellite technology, aviation and space travel and in some areas of microelectronics and materials", while Japan has reached a "top position in the low-cost and high-quality mass production of many components and devices."

Wild strongly advocated a liberalization of research with funds from third parties--which has already been discussed in Bonn--since after all the funds coming from industry directly to the universities account for only one tenth of all funds from third parties and furthermore "cooperation with industry does not limit the freedom of universities; on the contrary, it is almost the only effective means to extend this freedom."

Engineer Hans C. Koch, member of the board of directors of BMW AG, Munich, also discussed the possibilities for cooperation between industry and universities. He said that his company, for instance, is cooperating with approximately a dozen university institutes with a total of DM 2.5 million allocated for this purpose. And "in the past 3 years BMW alone granted approximately 150 theses to institutes in Bavaria." With regard to the new robot center Koch noted that it "was a real pleasure to witness the commitment and intense interest of the young students" in this research center. "This is the innovative climate which we need in the Federal Republic of Germany in view of our competitive situation with Japan and the United States--'in search of excellence' so to speak."

With regard to the financial participation of industry in the establishment of institutes, as for example in Dornach, Koch said that "I personally feel that science will still have sufficient free play to meet the standards of scientific work." He continued to say that the door assembly concept tested here has already progressed to such a stage that it can now be introduced into mass production and that there are in addition 'synergy effects' which are spreading to other efficiency improvement projects. "Without these preliminary basic experiments and research activities it would not have been justified to translate this concept into actual production."

In conclusion Koch touched again on the subject of research financing and in doing so probably promised further research contracts: "If the appropriate authorities continue to give you generous financial support this project can 'be counted' in the classical sense and can be recommended as an example."

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## MICROELECTRONICS

### LACK OF INVESTMENT HINDERS FRENCH MICROELECTRONICS PLAN

Paris ELECTRONIQUE ACTUALITES in French 29 Mar 85 pp 1, 18

[Article by J.P. Della Mussia: "Under Pressure From the Far East, and Despite R&D Totalling Over FF 800 Million This Year, the Microelectronics Plan Must Face a Change-of-Scale Problem"]

[Text] Halfway between 1983 and 1986, the period covered by the second French microelectronics plan, the government can boast that it did what was needed to meet more or less the goals set, in particular with respect to the recovery of the French trade balance for integrated circuits (the rate of coverage rose from 41 percent in 1982 to 58 percent in 1984) as well as with respect to job creation (of 6,000 jobs, 1,000 were created since 1982).

However, the government did not anticipate in 1982 the formidable pressure that U.S. and especially Japanese investments would exert on semiconductors in 1983 and 1984, so that the amounts invested in this field in 1984 by predominantly French-owned companies represented only 1.4 percent of the amounts invested worldwide, i.e. about the same proportion as in 1983. Unfortunately, if French investments did not take off compared with the worldwide average, it is to be feared, looking at figures only, that they will also not take off from their 58-percent position in the French balance of trade before the end of 1986 (assuming a consistent policy on the part of the "foreigners" established in France which, obviously, have an impact on that rate), considering that investments will begin to generate sales only one and half years after they are started.

Yet, the DIELI [Directorate of Electronics and Data-Processing Industries], where the subdirector in charge of components is traditionally responsible for coordinating the government's efforts in microelectronics, is expecting more attractive rates, ranging from 83 to 105 percent. But it does not conceal that the Japanese and Korean efforts now impose a reconsideration of the issue of investments in semiconductors, as a change of scale is required.

"Unfortunately, in the present context, we cannot afford to make the effort required. Certainly, for the new plan that will start in 1987, a European effort will have to be seriously considered. In addition, basic problems peculiar to the French, in particular in the social field, must be solved."

In the meanwhile, R&D financing for the microelectronics plan goes on about as planned: the government allocated FF 700 million in 1983, FF 820 million in 1984 and "a little over FF 820 million in 1985"; total appropriations for the plan, as planned in 1982, amounted to FF 3.2 billion for R&D only. But the crux of the problem nowadays lies more in investments than in research, and the people in charge of the plan have practically no influence in this respect: in particular, they have no say as far as capital appropriations for nationalized companies and the use of appropriated amounts are concerned.

#### The Change of Orientation of 1982

To understand the context of the French microelectronics plan, we must go back over the changes that marked the transition from the first 1978-1982 integrated-circuit plan to the 1983-1986 plan. In 1978, the first three declared goals of the plan were first to retain on French territory a systems knowhow that could be implemented in certain integrated circuits; to make sure that there would be a local supply source in case of a worldwide shortage; and finally to bridge the technological gap. The structures required to achieve this goal were set up during that plan, but late in 1981 everything remained to be done to tackle actual production problems. Unfortunately, 1982 was a lost year, due to the nationalizations: research kept going, but French industrial investments in semiconductors dropped probably to around FF 100 million: knowing that one franc invested in semiconductors will generate one franc of sales per year after one and a half years, we can easily imagine the impact that these FF 100 million had on sales during the boom period from mid-1983 to the end of 1984...

Since the end of 1982, however, the climate has changed drastically. This change had two causes: new political imperatives on the one hand, and an adjustment of the orientations of the first plan on the other hand.

The political aspect caused a shift in the above-mentioned first three goals of the plan; they are now:

- creating jobs;
- restoring the trade balance for integrated circuits;
- bridging the technological gap.

Fortunately, this shift in priorities was not in contradiction with the previous goals.

As for the adjustment of the orientations of the first plan, it involved:

- an expansion of the concept of efforts on integrated circuits to that of efforts on semiconductors, machines and materials; indeed, it was found that all this was very much interrelated.

- a very strong increase in R&D. The amount to be spent during 1983-1986 thus reached FF 3.2 billion to be provided by the government, essentially as repayable advances; the total amount provided for French research, including the companies and laboratories involved, amounts to FF 4.9 billion;



- the introduction of programs to promote the use of microelectronics in the industry, the best known of which is the PUCE program [Products Using Electronic Components]; indeed, people realized in 1982 that the industry's problem was not so much that it could lose its systems knowhow if integrated circuits embodying original ideas were manufactured abroad, but rather to take advantage of the potential of microelectronics to innovate and create new systems.

How did these principles translate into facts?

#### A Transition Period in 1986-1987

Concerning the sinews of war, i.e. the amounts allocated, we saw that as far as R&D is concerned the plan is proceeding almost as scheduled. In addition to the FF 820 million of credits provided in 1984 by the Ministry of Industry (DIELI), the Ministry of Defense (General Directorate of Armament), the Ministry of Post and Telecommunications (General Directorate of Telecommunications) and the Ministry of Research (the former General Directorate of Scientific and Technical Research), credits are also provided by the National Center for Telecommunications Studies, the Atomic Energy Commission and the National Center for Scientific Research. (Of the FF 820 million, FF 400 million are devoted to integrated circuits, including FF 300 million for metal-oxide semiconductors, FF 50 million for linear bipolar components, and FF 50 million for digital bipolar components). If we include manufacturers' efforts, FF 1.5 billion were spent in this field in 1984.

As far as investments are concerned, on the other hand, the planned course was not followed: in 1982, the plan provided for investment aids of FF 2.7 billion, with a peak in 1983; actually, no money was made available, so that the actors of the plan invested only FF 360 million in 1983, instead of the anticipated FF 870 million. In 1984, Thomson's capital appropriations contributed FF 600 million to its integrated-circuit operations, and the newly-created Industrial Modernization Fund contributed FF 400 million (in the form of 9.25-percent loans) to the investments of Matra-Harris Semiconductors, Thomson, Nanomask, Crismatec, Rhone-Siltec, etc. In 1985, FF 1.3 billion are likely to be invested, i.e. more than originally planned. In view of economic conditions, it would have been preferable to invest in 1982 and 1983 to take advantage of the favorable 1984 period. We shall see what is going to happen in 1986-1987, when investments should be made in preparation for the next boom...

#### Positive Results

The efforts made since 1982 have yielded positive results as far as the set goals are concerned. According to the DIELI, 1,000 jobs were created since that date. The trade balance rate of coverage rose from 43 percent at the end of 1981 to 41 percent in 1982 and 58 percent in 1984. (However, we should mention that export markets increased far more than the domestic market in 1984, which contributed to that rate). French companies' sales exclusively from semiconductors (studies excluded) rose from FF 280 million in 1981 to over FF 1.2 billion in 1984. As far as bridging the technology gap is concerned, French research will be implemented through agreements signed late

in 1984, on the one hand between Thomson and the LETI [Electronics and Data-Processing Technology Laboratory] and, on the other hand, between Matra-Harris-Semiconductor and the Norbert Segard center (the gap, however, has not been fully bridged yet).

Efforts in the fields of materials and production equipment are taking shape, and although they are not as ambitious as initially, now that Cameca has given up development of its photorepeaters and electronic masker, they have the merit of existing and often yielding some profitability for the companies involved. According to the DIELI, these companies generated sales of FF 450 million in 1984. Today, in France, French equipment accounts for 15 percent of an industrial production line.

However, this equipment now assumes such strategic importance in producing semiconductors economically that, in this field too, we should go on to the next higher stage. As far as aid to the use of microelectronics is concerned, the results achieved to-date are modest, but the effort has been made and will probably have a significant impact starting in 1987.

According to the DIELI, the effort made to train electronics designers and technicians increased by 72 the number of engineers who graduated in 1982, compared with previous years (i.e. a total of 200); this increase will be of 120 engineers in 1985 and 150 in 1986.

Finally, another positive result was the effort made to repatriate into France the integrated-circuit assembly facilities of the Far East. We already announced the initiatives taken by Thomson in Maxeville and Aix-les-Bains. It is now nearly certain that Matra-Harris-Semiconductors and SGS [expansion unknown] will also set up an automated assembly facility in Brittany (the project must be at an advanced stage, considering how intensely Nantes and Rennes are fighting to get the corresponding jobs). According to the DIELI, these facilities would mean the creation of 1,000 jobs until 1990, an additional FF 1 billion for the balance of trade, and 500 million parts assembled each year, still until 1990. They would also mean the purchase of 150 sewing [as published] machines (which are not manufactured in France, although this could have become a specialty of our former watchmaking industry) and a multitude of other effects on the manufacturers of gold wire and integrated-circuit combs (which will be manufactured respectively by Lyon-Alemand and Rhone-Poulenc Systems, among others) and plastics (not produced in France).

Of all the efforts mentioned, aid to the use of microelectronics is the most original since 1982, as it aids the semiconductors industry by increasing demand, a very sound method. We shall not go back over the PUCE program, whose scope is unfortunately still very modest (in Germany, FF 1.5 billion have already been devoted to the equivalent of that program, compared with FF 10 million in France), but we should emphasize specific efforts made by the government with automobile and consumer-equipment manufacturers. The goal of these efforts is to associate specialists of components and specialists of mass-produced equipment so they will define products jointly. An "Automotive Electronics Research Program" was thus set up by Peugeot

and Renault (currently, eight programs exist). Thanks to these efforts, Souriau achieved 1984 sales of FF 5 million with automobile connectors (R 25).

#### Transition to European Scale

Unfortunately, since 1982 negative factors also affected the progress of the plan, although they were none of the plan actors' doing.

The most negative factor, as is known, is the scope of U.S., Japanese and Korean investments. In 1983, the United States invested \$1.5 billion for semiconductors, and the Japanese as much; as for Europe, it invested \$300 million and France \$50 million. In 1984, the United States invested \$2.6 billion and the Japanese \$3.2 billion; meanwhile, Europe invested \$420 million and France \$100 million. As a result, the old continent will continue to play an insignificant part in the world concert in years to come. The only significant intra-European agreement is the Siemens-Philips agreement providing for FF 4.8 billion over 4 years. The ESPRIT program [European Strategic Program for Research and Development in Information Technology] will certainly have a considerable impact some day, but probably only after 1990. In the intermediate term, the time has now come to create at least a climate of confidence among European companies.

The second negative factor was the development of foreign industry in Scotland, Ireland and the FRG, which in practice does not bring us anything, quite on the contrary. The problem is largely a problem of labor costs. According to a DIELI survey, if our legislation allowed work around the clock, the French production capacity could be increased by 30 percent without any cost increase, and the number of jobs would be doubled (see Table). Now, it is a proven fact that today integrated circuit costs, all inclusive, are about 17 percent higher in France than in Scotland.

We should also say that the procedures to set up a company in Europe are far simpler in Scotland and in Ireland than in France, where it really takes a lot of patience and perseverance, considering the number of parties that must be contacted.

The DIELI also pointed out another negative factor: the fact that conditions in France do not encourage the creation of start-up companies.

In closing, the DIELI regrets the inadequacy of the efforts made with respect to production equipment, and mentions figures: the world market for semiconductors amounted to FF 260 billion in 1984, and equipment investments amounted to FF 25 billion that same year... To this should be added the fact that this equipment is becoming ever less indissociable from semiconductor performance. (In 1984, DIELI financing for this equipment amounted to FF 56.5 million, compared with FF 20.6 million in 1983 and FF 18.7 million in 1982).

<u>Item</u>	<u>Six 8-Hour Shifts</u>	<u>Six 8-Hour Shifts + Stand-ins</u>	<u>Six Shifts</u>	<u>Theoretical Model</u>
Workhours/week/shift	39	39 + 2 x 20	33	36
Total hours at workplace	117	157.5	199	213.5
Pause	12.5	13.5	10.5	10.5
Training, meetings, overlap	6	9.5	12	12
Vacation	12	16	21	23
Actual machine time	86.5	118.5	155.5	168
Hours paid	130	200.0	248	266
Cost ratio	1.5	1.6	1.59	1.58
Jobs	3	5	6	6
Capacity	1	1.37	1.80	1.94
Machine use	51%	71%	93%	100%

This synthesis, made by the DIELI based on industrial information, shows that machine-use time in the semiconductors industry could be increased from 71 percent to 93 percent of continuous-use time (100 percent) if present legislation (three eight-hour shifts + stand-ins) were to be replaced by work around the clock (most figures are in hours, the "vacation" item represents the write-off of vacation time over a week).

This change would double the number of jobs and should be viewed in the following context: write-off of one work-station in a diffusion unit: FF 430/hour; write-off of an assembly station: FF 145/hour; minimum wage: FF 25/hour.

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MICROELECTRONICS

BRIEFS

SIEMENS RAISES REGENSBURG INVESTMENT--Siemens, the leading West German manufacturer of electronic equipment, will invest close to DM 0.5 billion (FF 1.5 billion) in its Regensburg microprocessor plant, i.e. DM 170 million more than initially planned, the group announced on 21 March. Of these additional DM 170 million, 65 million will be spent on buildings, and the rest on technical equipment. The chips which Siemens will start manufacturing in Regensburg in 1987, with 250 employees, will have a memory capacity of 1 megabit. The project was initiated in collaboration with the Dutch leader Philips. The agreement signed by the two firms last year covers the research and development of these microprocessors, but not their production. [Text] [Paris AFP SCIENCES in French 28 Mar 85 p 44] 9294

FRANCE'S 'PUCE' PROGRAM PROGRESSES--The PUCE program [Products Using Electronic Components] launched in 1983 by Laurent Fabius (then minister of the industry) is designed to encourage companies to include electronic components in their products. Financial and consulting aid is provided in two stages. Once the application has been accepted, the company, aided by a microelectronics consultant (SSCM), must define its needs. At this evaluation level, aid cannot exceed FF 70,000. Then, the second stage involves the development of a prototype, for which aid cannot exceed 50 percent of the total cost (or FF 300,000). By the end of 1984, 72 applications had been processed, representing an investment of close to FF 6 million. Within the next 2 or 3 years, the DIELI [Directorate of Electronics and Data-Processing Industries] expects to finance 600 companies which, it says, represents 10 percent of "under-equipped" companies. [Text] [Paris MINIS ET MICROS in French 1 Apr 85 p 31] 9294

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## SCIENTIFIC AND INDUSTRIAL POLICY

FRG, FRENCH, UK R&D STRUCTURES, ACTIVITIES, FUNDING

FRG: S&T, Industrial Development

Stockholm UTLANDSRAPPORT in Swedish No 8501, Jan 85 pp 77-100

[Article by Hans Giertz]

[Excerpts] 1. Introduction

West German research and development (R&D) occupies a leading position on the international scene. In 1983 DM 46 billion, i.e. 2.8 percent of the gross national product, was used for R&D purposes. Here we present an overall view of where R&D is being conducted, who is financing R&D in West Germany, in what area R&D is being conducted, and the current trends--shifts in emphasis within West German R&D.

2. Where Is R&D Conducted, How Is it Financed?

2.1. General

Research and development in West Germany is financed by three main sources:

Federal authorities;

Federal states;

Business.

R&D is conducted in three primary areas:

Technical institutes and universities;

Scientific organizations;

Businesses.

Figure 1 shows the most important components of West German R&D and how resources for R&D are distributed from the organizations ordering the research and development to the organizations that conduct the R&D activity.

## 2.2. Financing

In West Germany, as in most Western countries, the majority of all R&D is financed by businesses. Businesses now finance 55 percent of all the R&D work. R&D accounts for about 75 percent of scientific expenditures.

Businesses also accounted for the greatest increase in R&D--an increase of about 66 percent during the past 6 years, compared to 51 percent for the states and 42 percent for the federal authorities during the same period. Business invested a total of DM 26 billion for R&D in 1983.

The second largest source is federal funding. In 1983 the federal government invested DM 13.5 billion for science, including DM 12 billion to support R&D. Most of this money was distributed almost evenly between scientific organizations and business. The distribution of appropriations is administered by several different ministries, the most important of which are:

BMFT, the Federal Ministry for Research and Technology,  
52 percent of appropriations;

BMBW, the Federal Ministry for Education and Science,  
14 percent of appropriations;

BMWi, the Federal Ministry for Business and the Economy,  
8 percent of appropriations;

BMVg, the Federal Ministry for Defense,  
15 percent of appropriations.

In 1983 the states invested just over DM 20 billion for scientific work, including DM 7.3 billion for R&D. The states are responsible for their own education systems. As a result, most appropriations by the states are distributed to their technical institutes and universities.

## 2.3. Performance

Business accounts for 67 percent of the R&D work with its emphasis (obviously) on practical applications. The level of self-financing is about 85 percent. This has tended to increase in recent years. Research is especially intense in the following fields:

Chemistry;

Steel;

Machine technology, vehicles, aircraft;

Electrotechnology;

Precision mechanics;

Optics

About 92 percent of all R&D resources were invested in these areas. These fields also are responsible for most exports and are experiencing the greatest growth of all industries. R&D in industry is concentrated among the large companies--48 percent of all R&D is carried out in industries with more than 10,000 employees and only 5 percent of the R&D work is conducted by industries with less than 1,000 employees.

Scientific organizations account for about 16 percent of the West German R&D work. The most important of these are the following:

The Max Planck Society, with its 49 institutes and 6,500 employees. Here basic research is conducted in natural science, but also in the humanities.

The Fraunhofer Society, with its 22 institutes and 2,000 employees. It is primarily involved in basic research on commission in the field of natural science.

Major research institutes. The Federal Republic now has 12 major research institutes. They employ a total of 20,000 people, including 6,000 researchers. The total budget for these institutes is almost DM 2 billion.

The federal republic has 88 technical institutes and universities and a number of specialized institutes of higher learning. The technical institutes and universities are run at the state level. As shown by figure 1, they receive most of their funding from the individual state in which they are located. The number of technical institutes has increased sharply in recent decades. The number of full-time, active researchers increased from 17,000 in 1960 to 70,000 in 1981. Note that this is a "statistical" value that indicates the number of "effective" researchers after teaching duties, etc., have been subtracted!

### 3. In Which Areas Is R&D Being Conducted?

#### 3.1. Business

Figure 2 presents a picture of the areas in which business is conducting R&D work. It also shows the extent of investments in 1981. The figure also indicates the percentage of the GNP for which each area is responsible, i.e. it shows indirectly how R&D-intensive the various areas are.

On average, West German industry invested 2.8 percent of its business volume in R&D in 1983. The following areas were extremely R&D-intensive:

Aviation and space--24 percent of total volume went to R&D;

Electrical engineering--7.3 percent of total volume went to R&D;

Precision mechanics, optics--5.3 percent of total volume for R&D;

Chemical industry--4.6 percent of total volume for R&D.



### 3.2. Federal

Figure 3 shows how the federal budget is distributed among the most important areas. The figure shows that energy research and energy technology receive the greatest support--about 20 percent of the federal R&D budget. These areas are followed by defense research, with about 15 percent. More information is also found in table 1.

Almost half the federal budget goes to business. Almost two thirds of this support goes to two areas (according to figure 2): "Steel, machinery (nuclear power plants!), and vehicle construction" and "Electrical engineering, precision mechanics, and optics."

## 4. Research Policy

### 4.1. General

When I asked West German Research Minister Dr Heinz Riesenhuber which areas he thought would have the highest priority in the future, his answer was short and to the point: "Microelectronics and biotechnology." When I followed up this question by asking what steps must be taken to make West German R&D more effective, especially considering the fact that West Germany has lost ground to the United States and Japan in these areas, he answered: "We are trying to make government research more effective at the major research institutes (Grossforschungseinrichtungen). We also want more initiative on the part of the industry. The latter is accomplished by moving from direct government support for R&D to indirect R&D support." Dr Riesenhuber's answer is nothing new, but a summary of the R&D policy he has conducted since he became research minister when the nonsocialist government was formed in 1982.

There are 12 state-run major research institutes. They employ 20,000 people. Their total budget is DM 2 billion. Although several institutes still have a good reputation and produce world-class research results, such as DESY (Deutsches Elektron-Synchrotron) in Hamburg and GSI (Gesellschaft fur Schwerionenforschung mbH) in Darmstadt, many of the institutes are producing mediocre results. Restructuring and reorganization are the remedies now being applied. There is limited political leeway, however. The researchers are government employees with lifetime job security. Fortunately, the major research institutes represent only a small part of the West German R&D community. The industry, the Fraunhofer Institute, the Max Planck Society, and the technical institutes and universities are producing world-class results.

The nonsocialist government believes it is extremely important that market forces not be eliminated by government interference. It believes that the previous government utilized too much direct project support, i.e. it reserved the right to decide whether or not funding would be provided in each individual project. Now the government wants to promote the ability of individual companies to be responsible for their own research activities by offering indirect research support. This means, among other things, the introduction of tax deductions for R&D investments, increased support for commissioned

research work, and general support programs in prioritized areas. As a result of these measures, they say, the relationship between indirect and direct R&D support to business has increased from 23 percent in 1982 to 45 percent in 1984.

In the future, state involvement in research will concentrate on the following areas:

- Base technologies, such as microelectronics, biotechnology, and materials;

- Major projects, such as the energy supply;

- Areas that have traditionally been within the sphere of interest of the government, such as defense, environmental, and health research.

#### 4.4. Space

The aerospace industry in West Germany is financed almost exclusively with federal funds. Just under DM 800 million was allocated in 1983. There are many indications that space activities will increase in the future. A long-range goal that has been mentioned is DM 20 billion in cumulative state support by the year 2000.

West German space activities are characterized by cooperation with other countries. Of course, European cooperation within the framework of ESA plays a significant role. In addition, there are a number of bilateral projects, especially with the United States and France. West German space activities are predominantly scientific in nature, but interest in utilizing space for commercial purposes is increasing.

At the latest French-German summit conference (on 30 October 1984 in Bad Kreuznach) Chancellor Kohl and Prime Minister Mitterand agreed in principle on three new space projects:

- Further development of the Ariane carrier rocket;

- Participation in the planned American space station;

- A French-German military reconnaissance satellite.

The HM-60/Ariane 5 is a two-fold project. The goal of its first phase is to produce a more powerful engine for the primarily French carrier rocket. Only with a stronger engine will the Ariane be able to achieve a service capacity of well over 15 tons in its lower orbit (up to 4,500 km above the earth) or over 8 tons in a geostationary orbit (36,000 km above the earth's surface). In phase two they will decide what type of craft will accompany the HM-60, i.e. the future Ariane 5, and whether or not the new HM-60 engine will be complemented by a "booster." It is estimated that the HM-60 will cost

DM 350 million in the preliminary stage and an additional DM 1,3 billion in the actual development stage. It is estimated that the Ariane itself will cost DM 3.6 billion. This project is a further development of the multilateral European cooperation within the framework of ESA.

So far, the West German share of the development costs in the Ariane program has been 20 percent. This has meant a 20-percent share of the feedback of technical solutions and knowhow.

In the new development stage of Ariane 5, however, it is unclear as to what share of the financial burden the Germans are willing to assume. They are having difficulties fitting a more ambitious share into their present research budget. They had hoped for a figure of 30 percent of the development costs for the HM-60. This would mean an additional DM 1.1 billion over and above their contribution to the already existing cooperation within ESA and other joint European space projects. Finance Minister Stoltenberg has proposed a lower share, 20 percent, but research leaders believe that the lower figure would cause them to lose what they call critical high technology.

Columbus was originally a German-Italian project to produce a larger and more long-lived space laboratory. Now the French have joined the project. Plans are for the Columbus to dock with a future American space station and, like Spacelab, it would link up with various American installations for supplies. It is a logical follow-up to the European Spacelab of 1983. All types of scientific and technical, but also purely commercial, tests and experiments will be conducted in it. The West Germans are hoping for 50 percent of the project (as with Spacelab). This would make them the largest European member of the joint enterprise. Financing remains an open question in the Columbus project as well. The DM 2.9 billion that would result from a 50-percent German share between now and 1995/1996, as well as the Ariane-5 funds, would have to come from a total research budget of DM 7.2 billion per year. Here, too, the Germans are considering the importance of a large share in the project in order to acquire the critical technology for themselves.

#### 4.5. Information Technology

The importance of information technology in modern society is undisputed and forms a cornerstone in federal West German R&D support. Information technology is one of the most rapidly growing areas, with a 20-percent annual average increase in federal support.

In March 1984 the federal government established an ambitious new program totaling DM 2.96 billion over the 5-year period of 1984-1988. This program emphasizes the following areas:

IC circuits, submicron technology, DM 600 million;

Industrial automation, DM 530 million;

Microperipherals, DM 320 million;

Fiber optics and broadband networks, DM 260 million.

In the area of semiconductor circuits (IC circuits) West Germany is now relatively far behind the United States and Japan. Only in early 1985 will Siemens begin producing a 256-kbit RAM. For the first time in many years, Siemens' component division is in the red.

Siemens is now announcing a major effort within what it calls the MEGA project. The chairman of the board at Siemens, Professor Beckurts, said: "Today West German IC technology is 2 years behind that of the United States and Japan. Within the MEGA project, we will produce a 1-Mbit RAM in 1987, which will put us just 1 year behind the United States and Japan. In 1989 we will produce a 4-Mbit RAM, which will make us even with the United States and Japan." To reach this goal, Siemens is investing DM 1.4 billion. A new factory is being built in Regensburg to produce the 1-Mbit dynamic RAM, at a cost of DM 320 million. Part of this development work is being done in cooperation with Philips. In a joint development project, Siemens will be responsible for developing a 4-Mbit dynamic RAM and Philips will develop a 1-Mbit Static RAM. Government support for this joint project will be DM 300 million from the West German government and DM 170 million from the Dutch government.

The Fraunhofer Institute in Berlin is now opening a new "Institute for Microstructure," whose main task will be to lay the groundwork for the next generation of semiconductor technology, in which X-ray lithography will be used in the production process. This work will be carried out in close cooperation with the German semiconductor industry, i.e. Siemens, Telefunken, Eurosil, and Volvo/Philips. The institute is being located in Berlin because the research will be based on the BESSY electron accelerator.

The telecommunications network is being constructed rapidly using fiber optics. Back in 1983 Postal Minister Schwartz-Schilling announced that, by 1995, the Deutsche Bundespost would install 1 million km of optical fiber in the telecommunications network. The major cities of West Germany are now linked by a north-south fiber-optic long-distance network. The Hamburg-Hannover link began operating during the fall of 1984.

Broadband communications have been in test operation since the beginning of 1984 in seven German cities, within the framework of a field test called BIGFON. West Germany is far advanced in this area by international standards. The Deutsche Bundespost is planning to introduce broadband communications, i.e. rapid data services and picture telephone, on a regular basis as early as 1989. The emphasis in the field of fiber optics is now on integrated optics and broadband communications.

The previously mentioned French-German summit conference in Bad Kreutznach dealt not only with R&D cooperation in space. The two sides also agreed to take concrete steps in the long-discussed French-German cooperation in the mobile-telephone sector. A joint, totally digital mobile-telephone system will begin operating in 1988/1989.

#### 4.6. Biotechnology

During the late 1960's West Germans realized that their research capacity in basic and applied microbiology was insufficient. Funds were set aside to increase the number of students, expand research, and hire more professors. In the early 1970's, the BMFT became interested in providing financial support for applied research out in the industry. Several projects with specific goals were initiated, including production of single-cell protein at Hoechst. The purpose of this project was to create an active interest in biotechnology within the business community and, at the same time, to support companies so that they could establish biotechnology laboratories at R&D centers. During the mid-1970's, BMFT became interested in genetics, hybrid DNA technology, and molecular biology. West German capacity was also low in these scientific disciplines. Federal and state financial resources were allocated to create so-called expert centers in genetics. There are now four such centers: Cologne (university and Max Planck Institute) specializing in plants, Heidelberg (university and the German cancer research institute), Munich (university and Max Planck Institute), and Berlin (university), which are partially funded by the Scheering Company.

The question is whether or not they have gone in over their heads by establishing four centers. The availability of highly qualified West German scientists is probably not great enough to maintain top quality in research at all these centers. The BMFT now plans to establish additional expert centers, such as in neurobiology, enzyme technology, and bioengineering. The goal is to coordinate and strengthen R&D in West Germany as much as possible. It should be added that the BMFT also helps finance the European research institute for molecular biology in Heidelberg. The governmental support program for biotechnology began in 1979. This program lasted from 1979 to 1983. A new, multiyear support program will begin in the spring of 1985. This program will be a continuation of the ideas and projects that were begun from 1979 to 1983. As previously indicated, the BMFT finances research and development of an applied nature within the industry. Even companies with high profit margins can receive support from the BMFT. The BMFT believes it is necessary to help companies by sharing the risk in "high risk projects" in order to motivate them to seek new and unconventional solutions. Another reason BMFT is involved in industrial projects is that it hopes to link academic research at the universities to the industry. The BMFT is also working to expand international post-doctoral exchange programs. During the 1970's, the industry had a wait-and-see attitude toward biotechnology. "Let us see what happens in the United States. If returns on invested capital prove to be promising there, then we will become involved." For several years now, however, the major companies have realized the potential of biotechnology and become actively involved in exploiting these possibilities. Discussions with R&D leaders at the large chemical and pharmaceutical companies Beyer and Hoechst revealed that their efforts are extremely goal-oriented. With regard to the training of researchers and engineers in the various biological sciences, industrial leaders believe that the universities and the Society for Biotechnological Research in Braunschweig have a sufficient capacity, quantitatively and qualitatively, to meet the demand. Universities in the

United States are used, to a high degree, for training specialists--post-doctoral work. The BMFT also has a support program for new companies in high technology fields. It contributes initial capital and management support. So far, about 10 small biotechnology companies have been formed in diagnostics and other areas. There is a full-scale debate underway over the ethical and legal aspects of using cell-biology and gene-technology methods on humans. New legislation also is expected that will govern the use of test animals in research. One goal of the legislation is to force the development of in vitro test methods. Finally, it should be noted that West Germany has to offer in biotechnological R&D is its activities in the improvement of plant breeding.

The following are some of the many projects that receive support from the federal government.

#### Food-Fodder

Production of single-cell protein from waste products such as molasses and cellulose;

Production of essential amino acids and fats;

Isolation of natural pigments, for example, from fruits;

Screening of microorganisms to find those that are suitable for the production of aromas.

#### Environmental protection

Isolation and structural determination of pheromone complexes;

Testing of various pheromones;

Searching for natural biologically active substances to combat insects, fungi, and weeds;

Optimizing the production and formulation processes for producing pathogenic viruses to be used against insects;

Development of biological reactors for treating wastewater and sludge;

Development of technology for anaerobic and aerobic treatment of industrial wastewater;

Studies on methane gas formation processes (thermophilic);

Composting of household waste;

Development of biological filters for cleaning ventilation air.

Cell cultivation for producing biologically active substances

Identification and characterization of surface proteins on viruses;

Identification and characterization of virus-specific tumor proteins;

Plant breeding

Selection of mutants with improved qualities.

Enzyme technology for producing basic chemicals

Enzymatic treatment of raw materials.

Extraction of metals with microbiological techniques

Uranium enrichment;

Metal recovery, for example from industrial waste.

Development of biotechnological methods

Biological reactors for cell systems;

Biological reactors for cell-free systems;

Measurement, monitoring, and control technology.

##### 5. International Comparison of West Germany's R&D Expenditures

West Germany spends 2.8 percent of its gross national product on research and development. This makes West Germany a world leader along with the United States, followed by Great Britain, Japan, and the Netherlands.

An international comparison also shows the important role of German business in research and development. Business finances 55 percent of the R&D work in West Germany. The share financed by business is greater only in Sweden and Japan (60 percent). In other industrialized countries of significance, the corresponding figure is around 45 percent.

In West Germany, 67 percent of the R&D work is carried out within the industry. Two countries have a higher percentage--70 percent in Sweden and 68 percent in the United States. The average is about 60 percent in the other industrialized countries.

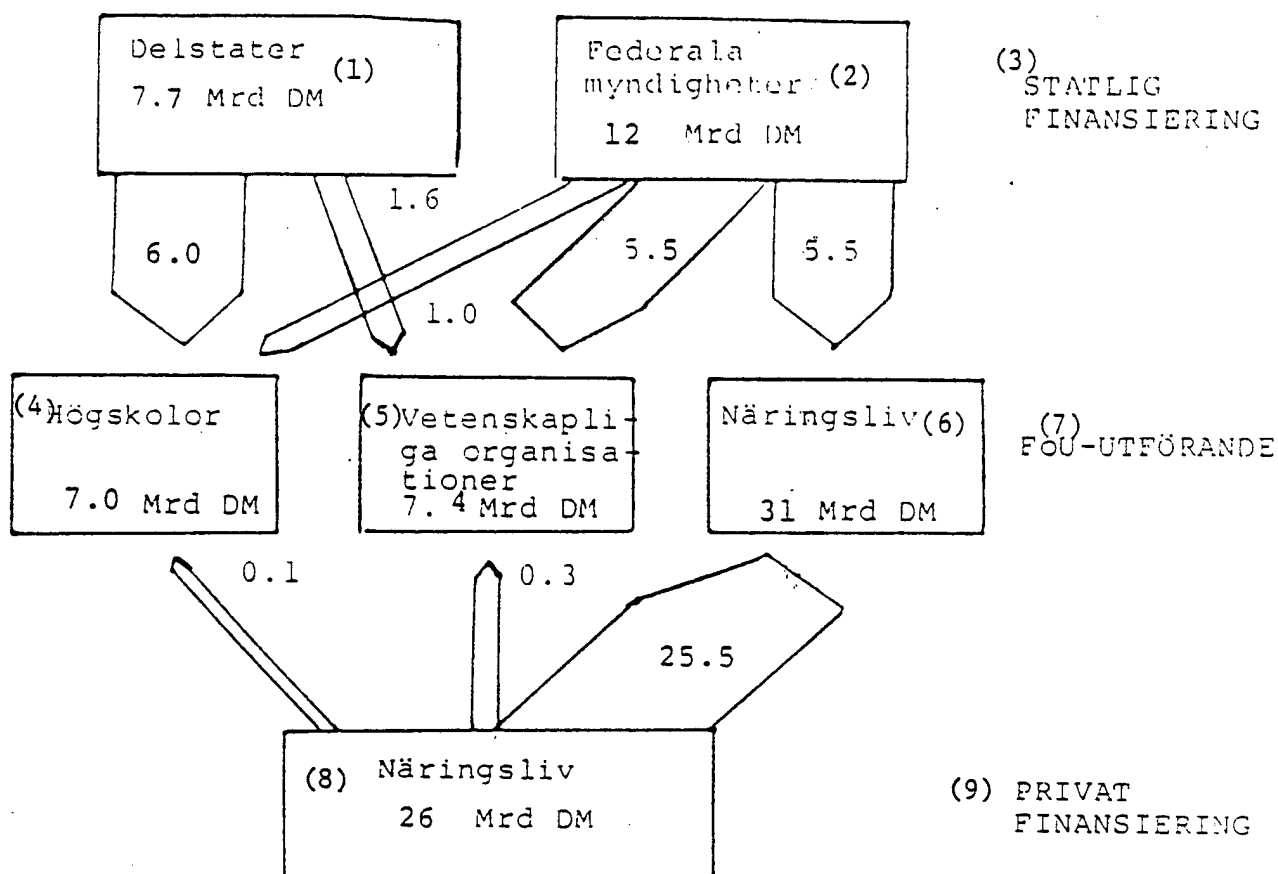


Figure 1. R&D in West Germany (Billions of DM, 1983).

Key:

1. States, DM 7.7 billion
2. Federal authorities, DM 12 billion
3. GOVERNMENT FINANCING
4. Universities and technological institutes, DM 7.0 billion
5. Scientific organizations, DM 7.4 billion
6. Business, DM 31 billion
7. R&D work carried out
8. Business, DM 26 billion
9. PRIVATE FINANCING.



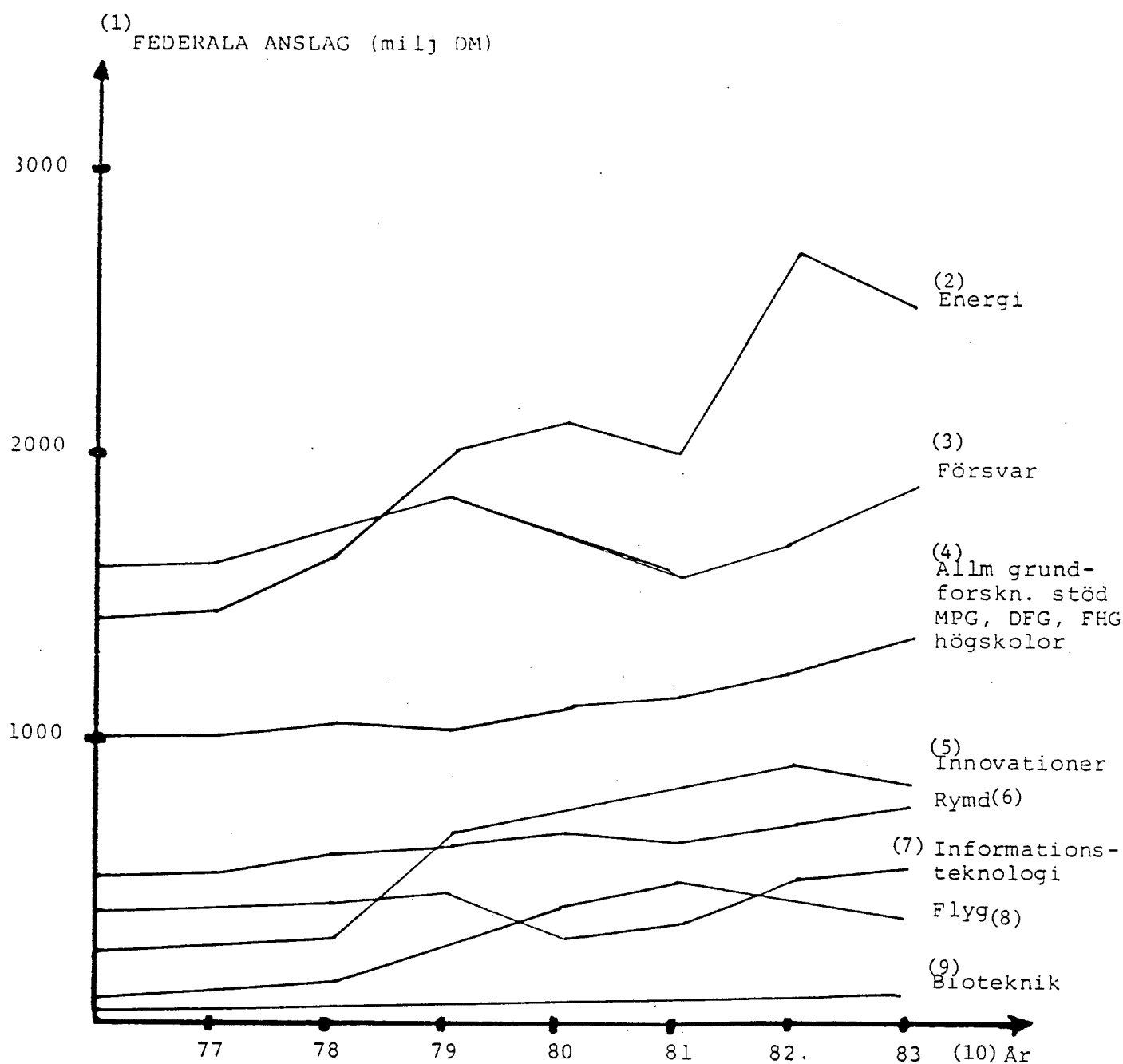


Figure 3. Distribution of federal appropriations in the most important fields. In 1983 to total federal R&D budget was DM 12 billion

Key to Figure 3:

1. FEDERAL APPROPRIATIONS, (Millions of DM)
2. Energy
3. Defense
4. Basic research, support to MPG, DFG, FHG institutes
5. Innovations
6. Space
7. Information technology
8. Aviation
9. Biotechnology
10. Year

Table 1. Research Ministry (BMFT) Budget for the Year 1985

Profile of the 1985 BMFT Budget  
(incl. institutional grants and international contributions)

Priority grants:	1985 budget in million DM	Change from 1984 in %	1985 share of total budget in %
I. Basic research and long-range fundamentally oriented research programs	(2,372.5)	(+ 6.8%)	(32.7%)
1. Max-Planck-Society (MPG)	407.8	+ 4.9%	5.6%
2. Selected fields of basic natural scientific research (unless included in the other priority items)	863.3	+ 8.4%	11.9%
3. Space research and technology	810.5	+ 7.7%	11.2%
4. Marine research and technology	162.8	+ 6.2%	2.2%
5. Polar research	64.4	- 5.0%	0.9%
6. Humanities and social sciences	63.7	+ 0.8%	0.9%
II. Acquisition of Orientation Knowledge	(91.2)	(+ 40.9%)	( 1.3%)
1. Ecological Effects Research	66.0	+ 39.0%	0.9%
2. Climate research	20.3	+ 35.0%	0.3%
3. Evaluation of technological effects (unless included in the other priority items)	4.9	+ 119.8%	0.1%

	1985 budget in million DM	Change from 1984 in %	1985 share of total budget in %
III. Promotion of research and development in central areas of the study of future state care	(2,930.2)	(- 4.4%)	(40.4%)
1. Environmental technologies; Water research	155.2	+ 2.2%	2.1%
2. Fossil and renewable energy sources; rational energy use	661.3	- 8.2%	9.1%
3. Nuclear energy research	1,625.4	- 5.8%	22.4%
4. Nuclear fusion research	74.4	+ 1.8%	1.0%
5. R&D in the service of health	310.4	+ 5.6%	4.3%
6. Humanizing life at work	103.5	+ 3.5%	1.4%
IV. Support for R&D to open up key technologies	(1,143.7)	(+ 6.5%)	(15.8%)
1. Information technology (incl. production technology)	658.0	+ 9.7%	9.1%
2. Material research (unless in- cluded in the other priority items)	82.5	+ 17.2%	1.1%
3. Biotechnology	124.8	+ 7.2%	1.7%
4. Physical technologies; chemical method technology	108.3	- 0.9%	1.5%
5. Aeronautical R&D	170.1	- 4.4%	2.3%
V. Improvement in the framework condi- tions for R&D and innovation in the economy	(379.5)	(+ 44.1%)	(5.4%)
1. Fraunhofer Society (FhG)	114.9	+ 6.0%	1.6%

	1985 budget in million DM	Change from 1984 in %	1985 share of total budget in %
2. Indirect support for additional personnel capacity for R&D	55.0	new priority item	0.8%
3. Improvement in transfer of technology and knowledge	57.2	+ 0.5%	0.8%
4. Support for technology-oriented enterprise startups; venture capital	60.0	+ 145.9%	0.8%
5. Technical information	92.4	+ 25.6%	1.3%
VI. Support of R&D and Innovation in the service of perception of public functions	( 276.6)	( - 17.8%)	( 3.8%)
1. Ground-tied transportation and traffic	186.1	- 15.8%	2.6%
2. Geosciences and raw material supply	81.5	- 23.9%	1.1%
3. Safety research and technology (unless included in the other priority items)	9.0	+ 5.9%	0.1%
VII. Other priority-related support for research and technology (scholarships, internat. cooperation, information on research and technology	45.2	+ 16.5%	0.6%
VIII. Administration	51.1	+ 0.3%	0.7%
IX. Overall Decrease in Spending	- 40.0	- 38.5%	-0.6%
Total 1985 BMFT Budget	7,250.0	+ 2.9%	100.0%

France: S&T, Industrial Development

Stockholm UTLANDSRAPPORT in Swedish No 8501, Jan 85 pp 101-107

[Article by Olle Nordling]

[Excerpts] 1. R&D Policy

In the restructuring of the government in July 1984, the former Industry and Research Ministry was divided into two ministries. Hubert Curien was appointed research minister and Edith Cresson was appointed industry ministry. The goal of this division, according to the New Prime Minister Laurent Fabius, was to strengthen the position of research in French policy and to reduce the competition for state funds between the modernization program and the research program. According to "Loi de l'Orientation," the strong, long-term R&D effort initiated by the French government in 1982 has continued, the R&D budget has gradually increased in real terms, and the newly appointed research minister, Hubert Curien, will once again receive a real increase in his budget, according to the proposal for 1985. All other ministries will have their budgets reduced in real terms.

In general, the R&D budget of the French government is divided into Fr 40 billion for civilian R&D and Fr 20 billion for military R&D. In addition, the industrial sector's R&D effort amounts to Fr 40 billion.

The original goal of spending 2.5 percent of GNP on research and development in 1985 will not be reached, but the 1984 results of about 2.3 percent of GNP represent a remarkable increase, compared to 1.3 percent in 1981. The goal established in 1982 was based on the assumption that industrial research and development would increase by an annual average of 8 percent, including 10 percent by the nationalized companies and 6 percent by private companies. The actual result was lower--9 percent annually for the nationalized companies and only 2 percent for private companies. It is stressed, however, that the private companies contributed toward a real increase in relative R&D investments, since the growth in GNP was lower--1.4 percent. This is especially remarkable, since industrial investments have declined in recent years: -5.4 percent in 1982 and -3 percent in 1983. Nevertheless, French industry still accounts for a lower share, 43 percent of the country's R&D investments, than in West Germany, for example, where the corresponding figure is almost 60 percent. R&D investments are also heterogeneous. There are significant differences among the various industries. Aviation, space, electronics, energy technology, and biotechnology top the list, while the food industry is in last place. By tradition, R&D investments are also concentrated among the largest companies in France. An effort has been made to increase the number of companies actively participating in R&D work from 1,300 companies in 1980 to 4 or 5 thousand in 1985. Despite a number of active government measures, this trend has developed much more slowly than planned and the goal has now been changed to 2,800 companies by 1988. The concentration of R&D work among the nationalized companies is striking. They are responsible for 58 percent of the R&D investments.

Since 1982 major changes have been made in the state budget during the fiscal year in question. This has caused much irritation. The policy for 1985 was changed in order to avoid such sudden shifts. In addition, more financing will be done through bank loans for certain projects that appear to be commercially sound. Initially, this will apply to the aviation industry, where the Falcon 900 and the Airbus A 320 will be partially financed in 1985 by loans of Fr 300 million, about 10 percent of this year's capital needs.

As a curiosity, it might be added that France is also using purely budgetary methods to achieve its goal of spending 2.5 percent of the GNP on R&D. For example, the ambitious project "Parc de la Villette," a large technological museum and information center, will be included in the R&D budget. This might be considered somewhat inappropriate and protests have been heard from the opposition, especially from rural delegates in the National Assembly.

### 3. Industrial Policy

Significant measures are being taken to modernize the production apparatus. One of the most important of these measures is the use of so-called FIM (Fond Industriel de Modernisation) loans with favorable interest rates of 9.75 percent and long repayment periods. FIM is administered by ANVAR (Agence Nationale pour la Valorisation de la Recherche), which is part of the Industry Ministry. In order to obtain a loan of this type, a French company must invest primarily in French-produced production equipment. Thus, the FIM loan system is also a protectionistic measure. The available funds are budgeted by industry and the electronics and engineering industries, for example, are especially favored.

So far, it has been difficult to gain popularity for this program among small and medium-sized industries (so-called PMI, Petites et Moyennes Industries), which have between 1 and 499 employees, for which these loans were primarily intended. The FIM program was initiated in September 1983. Preliminary figures indicate that by the end of 1984 it will have distributed Fr 10 billion to about 1,000 companies. Just over 20 percent of the FIM loans go to the so-called PMI companies, while three major companies with over 1,000 employees are dividing Fr 1.3 billion among themselves.

Previously, the formation of new companies in France was retarded by extensive regulations and administrative red tape. Simplification and rationalization of routines for starting new companies will take effect on 1 January 1985 and new forms of financing are expected.

### 4. Examples of Current Concrete Measures

#### 4.1. Thomson's Electronics Strategy

The nationalized Thomson company is aware that a sharp increase in Thomson's share of the world market is a necessity if it is to maintain its long-term

competitive strength, especially within the component sector, which requires intensive development work. Simply trying to increase the export of products the company has developed itself is insufficient. For this reason, a number of agreements were reached in rapid succession involving the licensed production of products for OKI of Japan, the German company AEG/Telefunken, and the American firms Motorola and IBM as a "second source." Along with Bull, Thomson is primarily responsible for making France one of the world's leaders in electronics and data processing, in accordance with the goal of "La loi de l'orientation" of 1982. On the whole, certain progress has been made. France's deficit in the trade balance for electronics and data-processing products has been reduced from Fr 13 billion to Fr 6 billion. Thomson believes it is especially important to achieve self-sufficiency for France in the future for strategic components. France is now dependent on the United States and Japan. This is seen as unsatisfactory and even downright dangerous.

#### 4.2. Biotechnology

In the strong international competition that currently prevails in this research-intensive field of technology, France holds two strong cards that should lead to success, namely a basic-research program of high international quality in both cellular and molecular biology and successful companies in the pharmaceutical, chemical, and food industries.

In 1982 the willingness to invest in biotechnology resulted in a multiyear government stimulus program. The French government is making long-term investments when it comes to "high technology." The goal is to build up a national base of expertise at government research centers and to intensify cooperation between the industry and academic research.

State investments from 1982 to 1984 are estimated at almost Fr 4 billion. The industry has been somewhat less interested in investing in biotechnology projects, but development work in biotechnology within the industry should increase during the upcoming years. Several of the large pharmaceutical and chemical companies, such as Rhone-Poulenc, Elf-Aquitaine/Sanofi, and Roussel-Uclaf, intend to invest considerable economic resources in biotechnology products in the next few years. They will also employ numerous specialists, researchers, and technicians. In late 1984 Sanofi will open its long-planned research center in Toulouse. About 100 researchers will work here in gene technology, industrial microbiology, and plant genetics.

The following has occurred in biotechnological R&D during 1984:

1. Basic R&D within the framework of the government's stimulus program.

Some examples.

- a) The project involving microorganisms of industrial interest with 40 subprojects, including the following:



physiological and structural characterization of *Bacillus Subtilis* strains, which are highly productive with regard to extracellular enzymes;

bacteriophages in thermophilic lactic acid bacteria;

artificial development of proteins in *Pseudomonas*;

mechanisms for the secretion of glutamate;

protein secretion in gram-negative bacteria.

b) Projects for the organization and expression of the genome eukaryote cells, with 28 subprojects including the following:

in vitro transcription of genes from yeast;

cloning and expression in *E. Coli* of various genes from the hepatitis B virus;

studies on gene expression of interferon in mice that are high- and low-level producers of interferon.

## 2. Scientific work of commercial significance in the field of immunology.

Immunotech, a spinoff company from the state-owned research center INSERM (Institut National de la Sante et de la Recherche Medicale), has announced that it has produced monoclonal antibodies for the in vitro detection of histamines.

The Gustave Roussy Institute announced that, in cooperation with the Massachusetts General Hospital in Boston, it has produced monoclonal antibodies for the in vitro detection of cancer of the liver.

Researchers at the Pierre and Marie Curie University have produced human monoclonal antibodies in vitro. This could lead to new therapeutic possibilities.

## 3. New Companies

Rhone-Merieux, a company that specializes in the production of vaccines, has formed the new company Transia. Transia will attempt to find new fields of application within the food industry for the expertise and techniques that have been developed within the chemical and pharmaceutical industries. One of Transia's first tasks will be to produce a test to demonstrate the presence of virus in milk.

Agri Obtentions is the first spinoff company from INRA (Institut National de la Recherche Agronomique). This company will be responsible for marketing INRA's know-how in the area of plant breeding.

#### 4. International cooperation

France is demonstrating a more and more open attitude when it comes to international cooperation in both academic and industrial research. This year the state-run chemical company Rhone-Poulenc has signed two cooperative agreements with American companies, Seedtech International Inc and Calgene Inc. The goal is to develop the French company's expertise in the area of plant breeding. One of the first projects involves sunflowers.

##### 4.3. The Ariane Project

The year 1984 brought a technical and commercial breakthrough for Ariane, the European space project under French leadership. Initially, this project was seen as a somewhat pathetic attempt to compete with the space shuttle of the United States. Following earlier failures and delays, this year's launches from the Kourou Base in French Guyana have been conducted with remarkable precision. Ariane 3, a new version with a greater capacity, was used for the first time in August and for an additional launch in November. It was a complete success in both cases. The strength of Ariane is that it can place satellites in geostationary orbits at a low cost and with high precision. Ariane is now a competitive alternative to the space shuttle. This is best demonstrated by the fact that it has launched two satellites this year, Spacenet 1 and 2, over the North American continent for the American telephone company GTE.

The market for the services that Ariane has to offer has grown rapidly and the order books are filled for several years to come. About 50 percent of the orders have come from non-European countries. The current price for parking a satellite in geostationary orbit is about Fr 30 million, so that this activity will become more and more of a commercial success.

##### Great Britain: Technical R&D

Stockholm UTLANDSRAPPORT in Swedish No 8501, Jan 85 pp 108-119

[Article by Dan Andree and Nils Starfelt]

[Excerpts] One of the authors, Nils Starfelt, has been at the London office for only 5 weeks. As a result, part of this report is based on "first impressions." Even though he has visited many laboratories and interviewed many people, some of his observations on industrial and R&D policy, in some cases, may not be totally representative of Great Britain as a whole.

##### Industrial, R&D Policy

Great Britain lacks two of the most important factors on which Sweden's industrial policy is based, namely a negative trade balance and a heavy dependence on imported energy. There are other reasons to be concerned about the future, however, such as the automobile industry's competition problems and the predominance of imports from Japan in areas such as electronics and machine tools.

One important question that is asked from time to time is the following: What will happen when we run out of oil? One common answer is that, at that time, the high-technology and service industries will play the most important role. Thus, it is important to invest in R&D and innovations.

At present, however, it is the older manufacturing industries that dominate the economy in Great Britain. Someone has stated the striking fact that if these industries suddenly disappeared, imports would increase from 61 billion pounds sterling to 162 billion pounds and the trade balance would go from +3 billion to -139 billion. One of the main problems the established industries are facing is a troubled labor market. This is best illustrated by the long coalminers' strike in 1984. Thus, there is a strong incentive for the industry to automate and, in this way, reduce its dependence on the unreliable human labor force. Responsibility for industrial policy and support is in the hands of the Department of Trade and Industry (DTI). It is interesting to note that, despite the government's almost reactionary position, government support to industry is both extensive and detailed. The government is trying to reduce the cost, however. The budget of 1.8 billion pounds for 1983/1984 is to be reduced to 1.4 billion in 1986/1987. R&D support, on the other hand, is to increase. Industrial support consists of four main components: export subsidies, consultation, support for investments in certain regions, and support for innovations. The total budget for support for innovations is about 250 billion pounds per year. Through May 1984, companies could receive subsidies totaling 33.3 percent of costs for development projects and market research. Now the figure has been reduced to 20 percent. The subsidies are not especially aimed at high technology. Subsidies of 50 percent are possible for some long-term R&D projects. In certain areas of technology, special investments are being made within the Alvey program. Other areas include biotechnology, CAD/CAM, FMS, and robotics.

Competition with Japan is a major source of concern. The trade balance with that country in 1983 was highly negative: -2.6 billion pounds. Since, as we know, it is difficult to increase exports to Japan, an effort is being made instead to reduce imports to Great Britain by convincing the Japanese to invest in production facilities in Great Britain and by promoting technological cooperation between Japanese and British firms. In 1983, 66 new Japanese investment projects were initiated in Great Britain. These joint technological projects include the Austin-Rover, Honda's new automobile, and a number of projects in the machine-tool and electronics industries.

#### R&D Budget

Appropriations for R&D in Great Britain, 1983/1984.

State	3.7 billion pounds
State-owned industry	0.4 billion pounds
Private industry	4.2 billion pounds
Total	8.3 billion pounds

#### Distribution of state budget, 1981/1982

Ministry of Defense	50 percent
Department of Education and Science	27 percent
Department of Industry	8 percent
Other	9 percent

#### R&D in industry, 1981

Total 3.8 billion pounds	
State appropriations to industry	30 percent
State appropriations to aviation industry	68 percent
State appropriations to electronics industry	50 percent

Number of employees in R&D 195,000

Thus, as in the United States and the Soviet Union, the bulk of the R&D work is conducted by the Defense Department.

#### Universities

The universities in Great Britain are experiencing serious economic difficulties. State appropriations, both direct and through research councils, are insufficient. One positive result of this has been increased cooperation between the universities and industry. Thus, some state appropriations have been replaced with money from the industry.

There is great interest at present in so-called science parks. Such parks now exist at nine universities and at least as many will be started in 1984 and 1985. The oldest were founded back in the sixties. They are at the Heriot-Watt University in Edinburgh and at Cambridge. The park at Cambridge has 49 companies and over 1,300 employees. The existing "science parks" vary considerably, but the common principle on which they are based is that the companies and the universities should both profit from their cooperation.

One university that has managed to expand in both education and research, despite the difficult economic conditions, is the Cranfield Institute of Technology. This has occurred because only 30 percent of the budget consists of appropriations from the government. The rest is research commissions and student fees. The institute specializes in training at the masters and doctoral levels. Many students have worked for several years before coming to Cranfield. As a result, many have their tuition and fees paid by their companies.

## Information Technology

Great Britain is now the largest consumer of integrated circuits in Europe. It passed West Germany in the fall of 1983 and Great Britain is now responsible for about 29 percent of the IC consumption in Europe. Interest in computers among the general public is extremely high. One home in nine now has a home computer, which makes Great Britain the world's leader. It is estimated that every other home will have a computer by 1986! Sinclair alone sells about 100,000 computers per month.

Of course, there is both good and bad news in this area. The National Economic Development Office (NEDO) recently published the report "Crisis Facing UK IT." Although sales in the IT industry have increased by almost 20 percent annually since 1980, the industry has lost shares of the market. The most serious threat today is the major shortage of engineers. NEDO says that the government must set a high priority on training in the IT field. NEDO also recommends more investments in civilian research and says that new ways must be found to stimulate medium-sized companies.

In the IT field, of course, it is the Alvey program that attracts the greatest interest, but there are also some other interesting R&D programs. The largest is the Microelectronics Industry Support Programme, which was initiated back in 1978 with 55 million pounds over a 5-year period. Now this program has been expanded and an additional 120 million pounds has been allocated for a 6-year period. The goal is to strengthen the British microelectronics industry.

### The Alvey Program

The Alvey program began in April 1983. The government is investing 200 million pounds over 5 years, while the industry is expected to invest 150 million pounds. At year's end (1984) about half the money has been allocated. Investments are being made in four areas of the information technology field: programming technology, human-machine communications, expert systems, and VLSI/CAD. In addition to these projects, there will be a number of large demonstrator projects. So far, four such projects have been initiated:

Design to Project, the purpose of which is to produce a fully automated factory. This work will be carried out by GEC Electrical Projects Ltd, the Artificial Intelligence Department of Edinburgh University, and the National Engineering Laboratory. The goal is to produce the framework for a system into which design data can be fed. The output would be a product, including maintenance instructions. Man-machine communications is an important part of the project. The Mobile Information Terminals project is intended to produce extremely flexible computer terminals for communications, data processing and presentation, and, especially important, "portability." This project includes BL Technology, the Human Sciences and Advanced Technology Research Group, Loughborough University, the Road Research Laboratory, and the software company SPL.

Explaining Legislation is the theme of the third project which, among other things, is to produce an "expert system" that may be consulted to determine eligibility for social benefits of various types. ICL, the Department of Health and Social Security, and Logica UK Ltd are involved in the project.

The Speech Input Word Processor and Workstation. Plessey has entered one of the most difficult areas, namely voice-controlled word-processing equipment. The goal is for the equipment to recognize over 5,000 words. Imperial College will produce the hardware, which is based on the INMOS transputer. Edinburgh University, Loughborough University, and Shell will also participate.

The four projects will cost about 10 million pounds each.

The Alvey program may be seen as a catalyst that is intended to initiate cooperation between various companies and the universities. Although 350 million pounds over 5 years may not seem like much, the Alvey program will double the more long-range R&D work in certain areas of industry. The Alvey program is also extremely important for the universities, which have suffered a 10-percent real reduction over the past 3 or 4 years.

#### INMOS

INMOS was established by the previous Labour government to reduce the dependence of Great Britain on the United States and Japan. After several uncertain years, it is now on a firm footing. This year INMOS was purchased by Thorn-EMI for 95 million pounds. This year sales are expected to total 100 million pounds and profits will be about 12 million pounds. Earlier this year it was announced that the Japanese firm NMB semiconductors had purchased the right to manufacture the INMOS 256 K DRAM on license. NMB said that the INMOS technology was much more advanced than that available in Japan.

Late last year INMOS introduced the "British supercircuit"--a transputer with processor, memory, and I/O units on a single circuit (250,000 components). In addition, a special real-time language for the transputer has been developed.

#### Sinclair

It would be difficult to avoid mentioning Sinclair in any discussion on IT. Earlier this year, we reported on the new "super home computer" for 400 pounds and Sinclair's plans to produce equipment for satellite reception that would cost 400 to 500 pounds. The latest news is that Sinclair has purchased a 12 year old (!) patent for WSI (wafer-scale integration) production. One of the secrets behind this patent is that the number of connections is extremely low--compared to that of Ahmdahl's (Trilogy) with over 1,000.

#### British Telecom (BT)

The government is continuing its efforts to privatize companies and it is now BT's turn. In November the sale of 51 percent of BT began. The government hopes to receive between 3 and 4 billion pounds. Since 1979 the government

has sold state-owned companies for 4 billion pounds. It hopes to sell additional companies for about 3 billion pounds annually during the upcoming years.

Since BT lost its monopoly position, it is OFTEL (Office of Telecommunications) in the Department of Trade and Industry that is now responsible for approving telecommunications equipment.

#### Electric Cars

Great Britain may be seen as a leader in the technical development and use of electric-powered vehicles.

Earlier this year, Bedford introduced the world's first mass-produced electric-powered van. The company plans to produce 10,000 of these vehicles annually. The price is about 9,700 pounds and operating costs are as low as 0.12 pounds per kilometer.

At present, tension is being focused on Sinclair which is expected to present its electric-powered car, which will seat two or three passengers. It will have a range of about 100 km and cost 1,500 pounds. Sinclair has invested 13 million pounds in this projects.

#### Silicon Glen

Europe's Silicon Valley is in Scotland and is called Silicon Glen. It has over 300 electronics companies. Among other things, they manufacture 80 percent of Great Britain's integrated circuits, which corresponds to 20 percent of the European production. This figure is expected to increase to 50 percent by 1986--and this with a population of only 5 million!

Companies that establish themselves in Scotland can receive subsidies totaling 30 to 40 percent of their investment costs. As a result, Scotland has become number one on the list for foreign companies that wish to invest in Europe. The economic advantages are not the only factors involved, however. Other factors that are at least as important are the skilled, willing, and relatively inexpensive labor force, good relations between management and employees, and plenty of room for expansion.

#### Materials Technology

There is tremendous activity in several areas of materials technology research in Great Britain. In 1983 DTI appointed an advisory group for materials technology. The purpose was to stimulate the industry to use new materials and, especially, to use known materials in better ways. It is also hoped that the group's work eventually will lead to a national R&D program with the participation of the state and industry groups, a program like the Alvey program in information technology.

The aviation and aerospace industry is investing heavily in materials development. This may be illustrated by the current priorities set by

British Aerospace and Rolls Royce. British Aerospace is now prioritizing the following areas:

- Carbon-fiber composites;

- Superplastic forming and diffusion bonding of Ti alloys;

- Al-Li alloys.

In the longer term, it will invest in the following:

- More advanced carbon fibers;

- Superplastic forming and diffusion bonding of Al alloys;

- Composites with a metal matrix.

Rolls Royce is investing in the following for its aircraft engine development:

- Casting of single crystals;

- Powder metallurgy for high temperatures;

- Titanium for high temperatures;

- Ceramics;

- Composites.

Some other examples of materials technology development are GKN's fiberglass-reinforced plate springs for automobiles, which will be mass produced beginning next year and ICI's coil springs of cement. A special process has been developed to reduce the porosity and, in this way, increase the tensile strength of the cement by a factor of more than 100. Perhaps coil springs are not the most dramatic practical application, but they illustrate the progress that has been made.

The National Engineering Laboratory (NEL) has developed a plastic spring that can replace steel at little or no additional cost. The development work has been underway for 5 years and now the patent has been approved. Automakers have already begun contacting NEL. The spring has applications in many fields, however, such as in dishwashers and washing machines and for reducing vibrations. The spring can be tailor-made to provide cushioning in various planes.

The newly formed company ER Fluid has developed a revolutionary fluid that hardens when it is subjected to electric current. The conversion from solid to liquid and vice versa takes only about 1 ms. A large number of applications for liquids of this type are seen: industrial robots, couplings of various types, artificial limbs, and others. Because of the rapid response time and the low current requirements, the liquid is well suited to be



controlled by a microprocessor.

#### Production Technology

At a press conference earlier this year, British Robot Association (BRA) presented statistics on robot installations in Great Britain. T. E. Brock, executive secretary of BRA, said that since this type of press conference was first held 4 years ago, the number of participants had actually decreased. This is not so much because there is less interest now, but because there was an enormous need for information and much curiosity 4 years ago. T. E. Brock believes that the participants today are much more knowledgeable than 4 years ago.

Number of robot installations in the UK:

December 1983	1,753
1982	1,152
1981	713
1980	371

This represents a 52-percent (!) increase over the previous year.

Other encouraging figures:

The number of new British robots has increased the British share of the market from 23 percent in 1982 to 34 percent in 1983. British-built robots now account for 28 percent (493 robots) of the total number.

There are 58 distributors of robots in the UK.

260 companies installed robots in 1983.

The number of installations in the UK in 1983 with 10 or more robots was four, with 77 robots in all.

Robot assembly showed the greatest increase--220 percent (!), totalling 103 robots.

The most important application is welding--33 percent.

It is not just the number of robots that is increasing. Three years ago there were about 9,000 NC machines in Great Britain. Now there are 28,000.

So far, the R&D work has been primarily "robot-oriented." For 4 years now the Science and Engineering Research Council (SERC) has been conducting the Robotics Initiative. So far, 4.6 million pounds has been invested by SERC. The Department of Trade and Industry (DTI) has support programs (Support for Innovation) in robotics, FMS, and CAD/CAM. SERC recently initiated a new R&D program: ACME (Application of Computers in Manufacturing Engineering). This project will be conducted in close cooperation with the Department of

## Trade and Industry.

Some of the areas that will be especially emphasized are the following:

- Evaluation of the performance of manufacturing systems;

- Development of sensor technology;

- Use of AI technology;

- "FMS islands" in existing plants;

- Design of products from the standpoint of function, economy, and production/assembly.

The majority of the projects will be carried out jointly by universities and companies. Another important part of the program is education and training. Among other things, a number of "retraining courses" will be set up for engineers with basic training in other areas.

Without question, the largest FMS project in the UK is that of Anderson & Strathclyde, which manufactures machines for mining. With the help of DTI, the company has invested 7.5 million pounds. The greatest investment is in five CNC machines for 5.5 million pounds. These are extremely large and heavy pieces of equipment (2.5 tons). Flexibility is extremely important. The order size is usually one! The company has managed to reduce the delivery time from 10 months to 7 months with the new system.

A special effort is being made in the area of CIM (Computer Integrated Manufacturing), within the framework of the European Esprit program. In 1983, 36 pilot projects were conducted, eight of which were in CIM.

Expert systems (AI) may be expected to be of increased significance in the manufacturing industry. NEL (National Engineering Laboratory), in conjunction with Edinburgh University and other, has formed a special expert systems group.

Dr P. Davey, who started SERC's Robotics Initiative, has formed his own company, Mets Machines. The company will market the laser-controlled robotic welding system that was developed at Oxford University. The firm will also continue to develop "intelligent" robotic systems.

Visual systems are becoming more and more common in the manufacturing industry. A large number of companies are involved, the most successful of which is British Robotics Systems. This company has about 20 installations, most of which are for inspection purposes. With regard to the universities' involvement in visual systems, the name Hull must be mentioned. Among other things, Hull has developed a camera that is mounted on the robot's arm. One interesting application is the separation of fabrics, which is an extremely difficult task.

Most of the sheet-metal pressing for Austin Rover and Jaguar is done at a factory in Swindon. The plant recently invested 20 million pounds in new technology that has increased productivity by more than 200 percent. Development work continues on a wholly computerized system for the design and production of pressing tools. A data base containing geometric data on the car bodies is used to design the tools and machining data is transferred directly to the machine tools. Lasers are used both for cutting and for surface hardening. This is believed to be the most important development in the British automobile industry in the past 20 years.

British Aerospace is extremely interested in carbon-fiber reinforced polymers. New production methods will be needed if the carbon-fiber technology is to compete with metals. Production of carbon-fiber reinforced components by hand is extremely time-consuming. Automation is needed. This also will result in better quality. Work is now underway with the so-called "type-lying" technique. This will mean a 10-fold improvement over manual production.

High-velocity water jets are being used for cutting composite materials. The pumping pressure is 4,000 bar and the nozzle diameter is 0.2 to 0.3 mm. Cutting with knives is more common in the United States. Lasers are inferior because they create bad edges. Water jets have been used previously for cutting leather in the shoe industry. The water jet technology has been developed by the British Hydromechanics Research Association. In one variant of this technology, an abrasive material is added to the water jet. This makes it possible to work with a wide variety of materials, including stainless steel. The pumping pressure need be no greater than 700 bar.

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SCIENTIFIC AND INDUSTRIAL POLICY

FRENCH 'TECHNOHUB' CLUB TO PROMOTE SCIENTIFIC COOPERATION

Paris AFP SCIENCES in French 28 Mar 85 p 13

[Unsigned article]

[Text] Grenoble--The French section of the International Technohub Club, which brings together high technology industrial centers, was created on 28 March at the National Center for Telecommunications (CNET) located at the Grenoble-Meylan Zone for Innovation and Scientific and Technical Research (ZIRST).

The Club of French Technohubs, which includes about 20 cities or agencies, was initiated by the president of Sophia-Antipolis, near Nice, who one year ago created the World Club of Technohubs and Scientific Parks.

Just like the world club, the objectives of the French section will be to organize meetings and information exchanges on what is new in scientific knowledge and techniques among manufacturers and its members, advise government agencies about the interests of technohubs, and facilitate exchanges of experience in various fields, such as technology transfers and the formation of enterprises.

In addition to Sophia-Antipolis and the Grenoble-Meylan ZIRST, the members of the Club of French Technohubs will be: Metz, Toulouse, Villeneuve d'Asq, Montpellier, Lyon-Aderly, Marseille-Chateau-Gombert, Nantes, Rennes-Alalante, Bordeaux-Technopolis, Strasbourg-Adira, Nancy-Brabois, the Gif-sur-Yvette City of Science, Paris-Sud, Marnes-la-Vallee, UTC-Compiègne, Savoie-Alp-Tech, St Etienne, and the National Institute for Technologies.

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